CCSDS File Delivery Protocol for Flight Applications

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Agenda

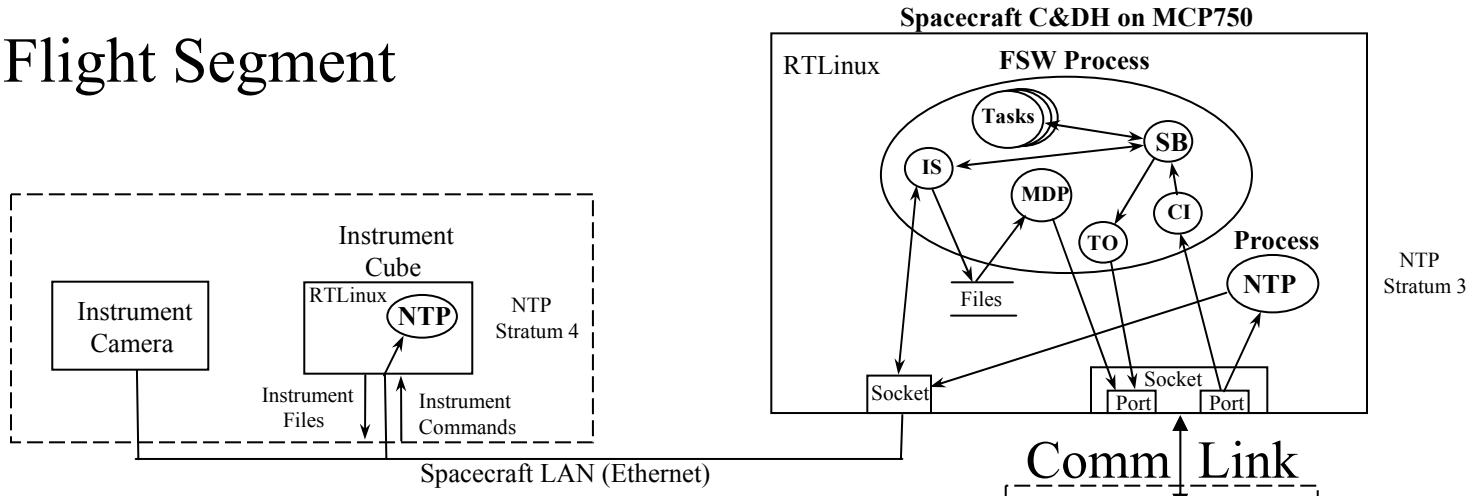
- "IP mission prototype" effort
- Technology Prototypes and GPM
- Multicast Dissemination Protocol vs. CCSDS File Delivery Protocol
- GPM requirements definition
- Summary and Conclusion

Introduction

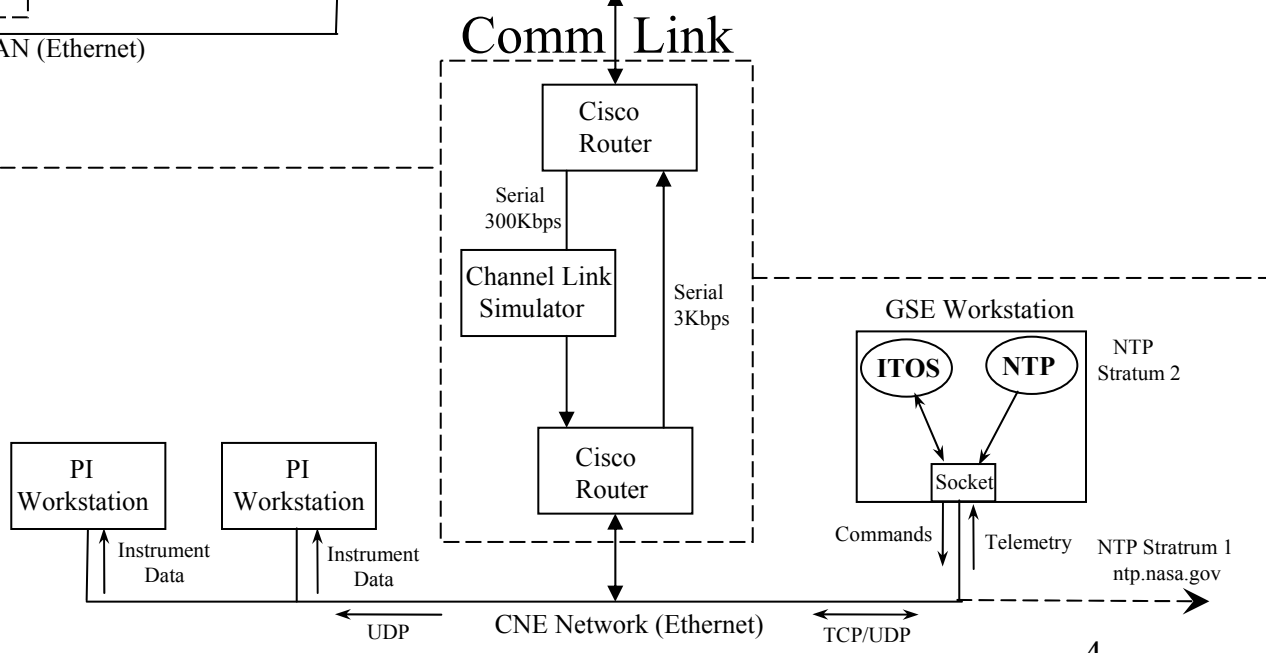
- FY02 Flight Software Branch and Advanced Architectures & Automation Branch, conducted a joint effort, "Demonstrating a Realistic IP Mission Prototype"
- Used COTS products, existing flight software architecture, and an embedded computer system.
- Lab effort used the following:
  - RTLinux
  - IP Space to Ground Interface
  - Multicast Dissemination Protocol
  - Network Time Protocol (Space-to-Ground I/F)
  - Triana mission flight software architecture.

Space Internet Technology Testbed Architecture

Flight Segment



Ground Segment



Technology and GPM

- Technology Prototypes
  - Flight Ethernet/IP Prototype (Flight Software Branch - Radiation Effects & Analysis Group)
    - Breadboard NIC hardware, drivers, network layer, redundant buses
  - IP Mission Prototype (Flight Software Branch, Advanced Architectures & Automation Branch)
- New technology prototypes influenced GPM to baseline the following:
  - Onboard LAN (work ongoing)
  - IP Space/Ground Interface (work ongoing)
  - Onboard file system
  - MDP for Space/Ground reliable and autonomous file transfer

MDP Feasibility for Flight

- Incomplete design documentation
- NRL proceeding with "Nak Oriented Reliable Multicast" (NORM) development
- Identified need for technical support from NRL
- No mission requirement for multicast
- Complex product, Maintenance concerns, Large memory requirements

CCSDS File Delivery Protocol

- CFDP has mature CCSDS Blue Book status with supporting Green Book
- Real-Time Software Engineering Branch, implementation by Tim Ray completed international testing on desktop environment
- Less complex product
- Better fit
- On-site technical support
- Performed comparative trade study
- Recommended CFDP for GPM mission

Highlights of MDP/CFDP Comparison

	MDP	**CFDP**
Published Standards	Expired IETF RFC	CCSDS Blue, Green Books available
Unicasting	Yes	Yes
Reliable File Delivery	Yes	Yes
Transaction Control Functions	MdpSessionQueueTxFile, MdpSessionQueueTxData, MdpSessionRemoveTxObject	Put, Suspend, Resume, Cancel, Report, Freeze, Thaw
Bi-directional File Transfer	Yes with multiple instances	Yes with 1 instance
Multiple Concurrent Transactions	Yes with multiple instances	Yes with 1 instance

Lab CFDP Prototype

- Developed CFDP application with "MDP demo functionality"
  - automated file detection and send
  - reliable file transfer over intermittent link
- Completed in 3 months
- MDP effort required 6 months

GPM Requirements Definition

- GPM Operational Concept continued refinement
  - Developed Use Cases and Scenarios
  - Requirements matured over 6 month period
- Key Items
  - 90 minute orbit
    - 20 minutes (Uplink 16 Kbps, Downlink 2.3 Mbps)
    - 70 minutes (230 Kbps Downlink only)
  - Send files continuously
  - During two-way link,
    - Resync CFDP partners
    - Resend data if necessary
    - Delete completed file transactions

GPM Requirements (continued)

- Key Items
  - Accommodate worst case mission scenario (track up to 12 hours of open file transactions) and recover
  - Implement directory prioritization
  - Design to accommodate N priorities and N directories
  - Implement "no-starve" priority algorithm
  - Expand to include Data Storage functionality
    - Include ground command to:
      - Set storage size per directory
      - Set overwrite/drop options when full
      - Set delete/no-delete file options after confirmed transfer
      - Set data routing options per directory
      - Set file size

GPM Requirements (continued)

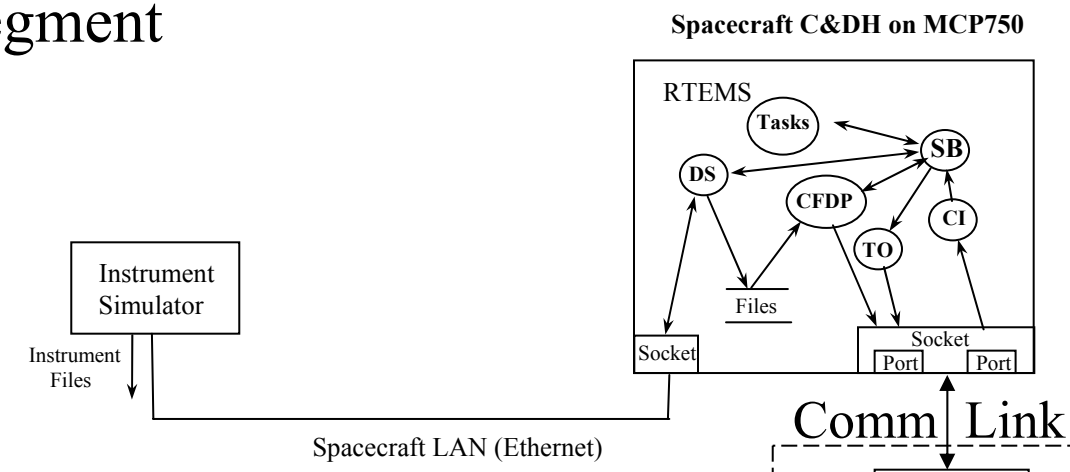
- Key Items
  - Expand to include File/Directory management functionality
    - Include ground commands to:
      - Create/Delete/Rename/Move files
      - Create/Delete/Move directories
      - List directory contents

CFDP Prototype Status

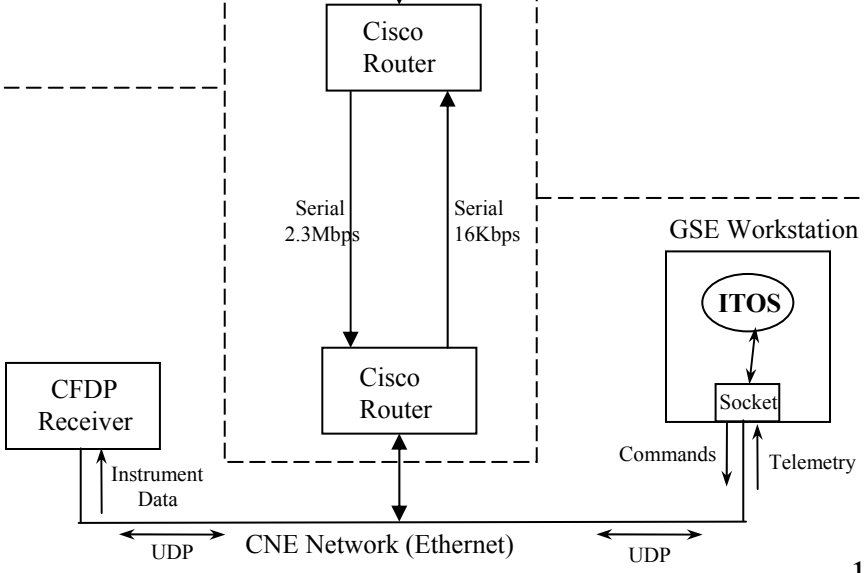
- Both segments
  - Implemented downlink only and two-way link features
- Flight segment
  - Implemented static memory allocation
- Ground segment
  - Buffer/Metered send of outgoing protocol messages
- Demonstrated
  - Downlink only and two-way operations
  - CFDP partner re-synchronization

CFDP Prototype Architecture

Flight Segment



Ground Segment



Ongoing Work

- Flight CFDP improvements
  - Data structure relocation to bulk memory
  - Scenario testing / debugging
  - Stress testing
  - Performance optimization
- Data Storage functionality
- File/Directory management functionality

Summary

- Mission Space/Ground file transfer started in lab effort with MDP
- Idea adopted by GPM mission
- CFDP
  - Better fit for intended use, Available technical support
- GPM mission concept refinement resulted in:
  - Increased CFDP functionality requirements
  - Identified additional requirements for Data storage and File/directory management
- GPM implementation for onboard file system and file transfer is underway

Conclusion

- COTS for flight use
  - Triggers new ideas for mission improvement
  - Mission needs are likely to result in significant product tailoring
  - Must consider technical support, maintenance issues, and worst case mission scenarios
  - Best result is currently a *generic product for multiple mission use*

CFDP Team

- Tim Ray
- Nancy Goodman
- Art Ferrer

Acronyms

- GPM - Global Precipitation Measurement
- CFDP - CCSDS File Deliver Protocol
- MDP - Multicast Dissemination Protocol
- COTS - Commercial Off-The-Shelf
- IETF - Internet Engineering Task Force
- RFC - Request for Comment
- LAN - Local Area Network
- NIC - Network Interface Card